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RESEARCH MEMORANDUM

FLIGHT MEASUREMENTS AT TRANSONIC SPEEDS OF THE BUFFETING CHARACTERISTICS OF THE XF-92A DELTA-WING RESEARCH AIRPLANE

By Thomas F. Baker and Wallace E. Johnson

High-Speed Flight Station
Edwards, Calif.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WASHINGTON

April 28, 1955

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SUMMARY

The 60° delta-wing XF-92A airplane has attained normal-force coefficients on the order of 0.7 in the Mach number range from 0.6 to 0.9. Mach numbers up to 1.01 have been attained during dives at lower lifts. In the present tests, measurements were made of buffet-induced fluctuations in normal acceleration at the airplane center of gravity and of fluctuations in structural shear load of the left wing. The altitude range of the investigation varied from 25,000 to 38,000 feet.

Buffeting was experienced at normal-force coefficients on the order of 0.2 at Mach numbers up to 0.88 but existed at normal-force coefficients less than 0.1 at Mach numbers between 0.9 and 0.96. Buffeting was not encountered at Mach numbers between 0.96 and 1.01 at low lifts.

At the altitudes of the present investigation, the buffeting encountered below the reduction in stability boundary was barely noticed by the pilot. Above the reduction in stability boundary the pilot described the buffeting as "moderate," but in comparison with the stability difficulties experienced by the airplane, the buffeting was not considered a problem. In general, the variation of buffet intensity with Mach number and lift is similar to that of other fighter-type airplanes except that the various levels of buffet intensity occur at lower values of lift and angle of attack. At a dynamic pressure of 300 pounds per square foot the peak values of wing buffet loads approached 10 percent of the estimated design limit load and below a normal-force coefficient of 0.6 the wing buffet loads approached 5 percent of the estimated design limit load.

INTRODUCTION

The buffeting encountered by current airplanes can be objectionable from both a structural and a handling-qualities standpoint and since the exact mechanism of buffeting is as yet not fully understood, it is desirable to document, insofar as possible, the general buffeting characteristics of various current airplane configurations. It is the purpose of this paper to present the buffeting characteristics of the 60° delta-wing XF-92A airplane, and to show the regions where the airplane encountered buffeting and the degree of buffeting experienced. Measurements were made of buffet-induced fluctuations in normal acceleration at the airplane center of gravity and of fluctuations in structural shear load of the left wing. The data are presented for normal-force coefficients up to about 0.7 in the Mach number range from 0.6 to 0.9 and for lower normal-force coefficients at Mach numbers up to 0.96.

The flight tests of the XF-92A airplane were conducted by the NACA High-Speed Flight Station at Edwards, Calif. The results of various other investigations of the flight characteristics of the XF-92A airplane are reported in references 1 to 3.

SYMBOLS

C_{N_A}	airplane normal-force coefficient, $\frac{nW}{qS}$
C_{N_W}	wing panel normal-force coefficient, $\frac{N_W}{qS_W}$
g	acceleration due to gravity, ft/sec^2
h_p	pressure altitude, ft
M	free-stream Mach number
M.A.C.	mean aerodynamic chord, ft
N_W	aerodynamic normal force on wing panel, lb
n	airplane load factor
q	dynamic pressure, lb/ft^2
S	total wing area, ft^2

S_W — area of wing outboard of strain-gage station (fig. 3) and herein defined as wing panel, ft^2

V — structural shear load acting normal to wing panel

W — airplane weight, lb

W_W — weight of left and right wing panels, lb

α — angle of attack, deg

Δa_n — incremental fluctuation of normal acceleration at center of gravity due to buffeting, $\pm$g units

$\left(\Delta a_n\right)_{\Delta V}$ — incremental acceleration that would result from direct action of twice the measured wing buffet load on a rigid body of mass equal to that of the present airplane without wings, $\frac{2\Delta V}{W - W_W}$

ΔC_{a_n} — coefficient of incremental normal acceleration due to buffeting, $\frac{W\Delta a_n}{qS}$

ΔC_V — coefficient of incremental structural shear load of the wing panel, $\frac{\Delta V}{qS_W}$

ΔV — incremental structural shear load normal to wing panel due to buffeting, $\pm$lb

δ_e — longitudinal control angle, deg

Subscripts:

max — maximum

AIRPLANE

The Convair XF-92A is a single-place 60° delta-wing airplane powered by a turbojet engine and afterburner. The airplane has a delta-shaped vertical fin but no horizontal tail. Longitudinal and lateral control is achieved by elevons which comprise the entire trailing edge of the wing.

There are no leading- or trailing-edge slats or flaps, no wing fences, and no dive brakes. A three-view drawing of the airplane is shown in figure 1 and photographs of the airplane are presented in figure 2. Table I lists the physical characteristics of the airplane.

The construction of the airplane is conventional. The fuselage is stressed-skin semi-monocoque with skin backed up by ring-shaped frames. All fuel, test equipment, and instrumentation is carried within the fuselage. The wing is of four-spar construction as shown in figure 3. The forward and main spars are continuous through the fuselage. The rear spar is pin-jointed at the side of the fuselage. The ribs and lower skin are cut out forward of the main spar for the landing-gear well. The landing-gear support is attached directly to the fuselage structure and only the up-lock is attached to the wing structure.

Resonant structural frequencies were obtained during ground vibration tests of the airplane conducted by the manufacturer (ref. 4). The natural structural frequencies and corresponding mode shapes of the wing were determined for frequencies up to 50 cycles per second. During resonant vibration, appreciable deformation of the wing occurred along chord lines in addition to spanwise deformation. Sketches from reference 4 showing the relative amplitudes of various points on the airplane for three frequencies are reproduced in figures 4(a) to 4(c). The wing and fuselage node lines are shown in figure 4(d) for all of the wing resonant frequencies determined during vibration tests.

INSTRUMENTATION AND ACCURACY

Instruments

The airplane was equipped with standard NACA recording instruments for measuring airspeed, altitude, angle of attack, control-surface position, pressure distribution on the left wing, and three components of acceleration. In addition, motion pictures were taken of tufts glued to a portion of the right wing. The airspeed head and angle-of-attack vane were mounted on a nose boom projecting from the air inlet duct. (See fig. 1.) Strain gages are installed at the roots of both wings (fig. 3) to measure shear load, bending moment, and pitching moment. A fluid-damped Statham accelerometer, maintained at a constant temperature by a thermostatically controlled heating jacket, was installed near the airplane center of gravity for measuring fluctuations in normal acceleration during buffeting. The strain gages and Statham accelerometer were recorded on an 18-channel Consolidated recording oscillograph. All instruments were synchronized by a common timer.

Strain-Gage Calibration

The strain gages were calibrated in terms of shear, bending moment, and pitching moment by applying concentrated static loads at numerous points on the structure. By electrical combination of three shear-gage bridges, located on the front, center, and rear wing spars, it was possible to obtain the shear load on the left wing panel from the output on a single oscillograph channel such that

$$\text{Structural shear load} = 6{,}050 \times \text{Combined strain-gage output}$$

During buffeting, incremental fluctuations in the output of the combined shear gages are, accordingly, proportional to the fluctuations in structural shear load. The accuracy with which the constant of proportionality (6,050) was determined during static calibration of the strain gages is estimated to be ±5 percent.

Accuracy

The estimated accuracies of the quantities presented in this paper are as follows:

M	±0.01
C_{N_A}	±0.01
C_{N_W}	±0.02
a, deg	±1.0
δ_e, deg	±0.5
ΔC_{a_n}, percent	±5
ΔC_V, percent	±6

The airspeed installation was calibrated by using the radar phototheodolite method of reference 5. The recorded angle of attack was corrected for nose-boom bending (0.16° per g) but no corrections for vane floating, upwash, or air loads on the boom were made. Fluctuating accelerations, measured with the Statham accelerometer, were recorded flat (within ±5 percent) to 60 cycles per second. All strain-gage outputs were recorded flat to at least 60 cycles per second.

TESTS

The data presented in this paper were taken during seven flights made for the purpose of determining the longitudinal stability and damping of the airplane. The flights consisted of dives to supersonic Mach numbers ($M_{max} \approx 1.01$) and of turns initiated in the Mach number range from

0.72 to 0.95. From these tests it was desired to determine the effect of lift coefficient, angle of attack, and Mach number on the buffeting of the airplane at 35,000 feet. However, because of low thrust and high drag due to lift, large altitude losses were incurred during dives to high Mach number and during turns in which the pilot attempted to hold reasonably constant Mach number. In addition, the airplane encountered a region of marked reduction in longitudinal stability at moderate lift coefficients with the result that "pitch-ups" and pitching oscillations within this region occurred. In order to obtain any data at moderate or high lifts, it was necessary to utilize the data taken during essentially uncontrolled maneuvers. However, data taken during periods of extreme positive or negative pitching velocity are not presented herein.

Typical records taken during buffeting flight are reproduced in figure 5. The quantities shown on the oscillograph record are as follows:

Quantity		Trace number
Shear, front spar	Left wing	1
Shear, front spar	Right wing	2
Shear, rear spar	Right wing	3
Torque gage	Right wing	4
Combined bending	Left wing	5
Torque gage	Left wing	6
Combined shear	Right wing	7
Shear, main spar	Right wing	8
Combined bending	Right wing	9
Shear, main spar	Left wing	10
Combined shear	Left wing	11
Normal acceleration at center of gravity (Statham)		12

Normal acceleration indicated by a low-frequency air-damped accelerometer is included in figure 5 to illustrate the low-frequency fluctuations in acceleration. The magnitude of the buffeting indicated by this low-frequency instrument was not evaluated. The values of buffet intensity presented herein were determined by measuring the amplitudes of the fluctuations of oscillograph channels 11 and 12 which measured left wing shear and normal acceleration at the airplane center of gravity as indicated by the Statham accelerometer, respectively. (Data obtained from the records reproduced in figure 5 are presented subsequently in figure 8(a).)

All data were taken with the airplane in the clean condition (gear retracted). Maximum lift as evidenced by a leveling or decrease in airplane normal-force coefficient with increase in angle of attack was not attained. Actual test limits are shown in figure 6. Altitudes for the tests varied from 38,000 to 25,000 feet. In order to minimize the effect of altitude variation, it has been assumed herein that the magnitudes of acceleration and load fluctuations are directly proportional to dynamic pressure. It should be noted, however, that some data have been presented in reference 6 which indicate that buffet magnitudes may be more proportional to the square root of dynamic pressure than to the first power. Should the results of reference 6 be applicable to the present data, the coefficients of buffet loads and accelerations presented herein would be low by a factor of the square root of dynamic pressure.

RESULTS AND DISCUSSION

Buffet Boundary

The buffet boundary, the boundary for a reduction in longitudinal stability (ref. 1), and the test limits of the present investigation are shown in figure 6. Curves indicating the values of normal-force coefficient required for 1 g flight as altitudes of 25,000 and 40,000 feet are also shown in figure 6(a) as a matter of interest.

The buffet boundary was determined by inspection of wing strain-gage records and records of normal acceleration at the airplane center of gravity. The onset of buffeting was taken as the first point at which fluctuations of the photographic trace became apparent, or at which an increase in the residual amplitude of the trace occurred, as lift was increased or as speed was changed. The onset of buffeting, as indicated by fluctuations in normal acceleration, and the onset of wing buffeting, as indicated by wing spar stress fluctuations, occurred simultaneously. For this airplane wing-panel normal-force coefficient C_{N_W} is essentially equal to airplane normal-force coefficient C_{N_A} for values of C_{N_A} less than 0.5. Accordingly, the buffet boundary presented in figure 6(a) also describes the onset of wing buffeting in terms of wing-panel lift.

The onset of buffeting in the Mach number range from 0.6 to 0.88 is attributed to the occurrence of leading-edge vortex-type flow at an angle of attack of about 5°. This flow condition is described subsequently. The abrupt decrease in the buffet boundary which occurs in the Mach number range from 0.88 to 0.93 probably results from shock-induced separation over the trailing inboard part of the wing. Buffeting existed at the minimum values of normal-force coefficient attained $\left(C_{N_A} \approx 0.07\right)$ in the Mach number range from 0.93 to 0.96 but buffeting was not detected at Mach numbers between 0.96 to 1.01 $\left(M_{max}\right)$.

It should be noted that about 28 percent of the exposed wing area is utilized for longitudinal control and trim. Elevon deflection at the start of buffeting in the Mach number range from 0.6 to 0.93 was on the order of 3° to 4° up. At a Mach number of 0.96, elevon position varied from 2° to 5° up. The effects of elevon deflection on the buffeting characteristics of the airplane are not known, however, except for the reduction in lifting effectiveness of the wing which is estimated to be equivalent to a decrement in C_{N_A} on the order of 0.05 at the buffet boundary.

At the altitudes of the present investigation, the buffeting encountered below the reduction in stability boundary (fig. 6), was barely noticed by the pilot. Above the reduction in stability boundary the airplane has severe pitch-up and longitudinal oscillatory characteristics which are discussed in reference 1. The buffeting encountered by the airplane above the reduction in stability boundary is described by the pilot as "moderate," but was not considered a problem in comparison with the stability difficulties experienced by the airplane.

Wing Flow Conditions

Wing streamwise section lift coefficients (obtained from pressure-distribution measurements) for five spanwise stations are presented in figure 7(a) for a Mach number of 0.7. The progressive loss in section lift from the tip inboard as angle of attack increased is apparent. Motion pictures of tufts on a portion of the wing and evidence of fluctuations in the records of wing pressure at each orifice indicated, qualitatively, that, in the Mach number range from 0.6 to 0.93, flow separation occurred over the wing tip at angles of attack on the order of 5° and extended inboard along the leading edge and over an increasing area of the tip as angle of attack increased. These flow characteristics are similar to those described in reference 7 (low-speed tests of a mock-up of the XF-92A airplane and referred to as the "NACA 65-series model" therein) in which evidence pointed to the existence of a separation vortex along the leading edge of the wing. In the present tests, the shape of the upper wing surface pressure distribution did not clearly define the existence of a leading-edge vortex at low angles of attack. At high angles of attack, the pressure distributions, of which figure 7(b) is typical, exhibited a trough parallel to the leading edge. Such a trough is considered characteristic of vortex-type flow.

At lift coefficients close to the buffet boundary in the Mach number range from 0.87 to 0.92, pressure-distribution measurements indicated the presence of a normal shock ahead of the elevon over the inboard 50 percent of the wing, and tuft observations showed the flow to be disturbed over the trailing inboard part of the wing. In the Mach number range from 0.92 to 0.96 at $C_{N_A} \approx 0.9.$, the shock appeared to be located at the elevon hinge line. Above $M \approx 0.97$, the pressure-distribution data indicated that the shock was at or near the trailing edge of the wing.

Wing pressure distributions for the XF-92A airplane at low lift and transonic speeds are presented in reference 2. The results of pressure-distribution measurements at higher lifts are as yet unpublished.

Buffet Frequencies

The frequencies at which buffeting occurred were determined by visual spot-check inspection of strain-gage and accelerometer outputs which were photographically recorded as a function of time. (See fig. 5). The predominant amplitudes of acceleration fluctuations recorded by the Statham accelerometer at the center of gravity occurred at frequencies on the order of 60 and 100 cycles per second but at times these two frequencies were superimposed on fluctuations of 14 to 15 cycles per second. Engine vibrations at about 200 cycles per second were also picked up by the Statham accelerometer with noticeable amplitude. A low-frequency air-damped, normal accelerometer, also located at the airplane center of gravity and which had negligible response to frequencies above 25 cycles per second, indicated buffet-induced fluctuations of 14 to 15 cycles per second. The combined strain gages, from which the increments in wing buffet shear load were obtained, fluctuated with predominant amplitudes at frequencies on the order of 26, 45, and 100 cycles per second. Fluctuations in the outputs of individually recorded shear gages located at the roots of the wing spars occurred at frequencies similar to the fluctuations in the combined shear-gage output. Strain gages installed in the wing to measure bending moment and torque responded at 14 to 15 cycles per second and at about 45 cycles per second during buffeting. Frequencies of 60 cycles per second and higher were not observed in either the torque or the bending-gage outputs.

No appreciable variation in buffet frequencies with aerodynamic conditions was observed within the test limits of the present investigation. The natural structural modes to which the predominant buffet frequencies appeared to correspond were a symmetric mode of wing bending at 14.12 cycles per second, and a mode of wing torsion. Three torsional modes are given in reference 4, an antisymmetric mode at 45.1, a symmetric mode at 47.6, and another antisymmetric mode at 48.3 cycles per second. The mode shapes for the 14.12- and the 48.3-cycle-per-second modes were shown in figure 4 together with the node lines for all of the wing natural frequencies. The structural modes to which the 60- and 100-cycle-per-second buffet frequencies correspond are unknown since the ground vibration tests extended only to about 50 cycles per second.

Buffet Intensities

Typical values of the coefficient of incremental normal acceleration ΔC_{a_n} as measured with the Statham accelerometer at the airplane center of gravity, and the coefficient of incremental structural wing shear load ΔC_V, together with some pertinent steady quantities, are presented in figure 8 as a function of angle of attack. The data were taken during three wind-up turns at Mach numbers of approximately 0.7, 0.85, and 0.9. The buffet-intensity data, ΔC_{a_n} and ΔC_V, were determined by fairing envelopes about the fluctuating accelerometer and strain-gage records and measuring the amplitudes of the faired envelope each 0.1 second during the maneuver. The envelopes were faired about the records without regard for the frequency content of the record. The values of ΔC_{a_n} and ΔC_V thus represent the resultant of acceleration or structural load fluctuations from 14 to 100 cycles per second. The values of ΔC_{a_n} shown in figure 8 at angles of attack below the points indicated as "buffet onset" result from the response of the accelerometer to engine vibration. Upper limits are shown faired about the values of ΔC_{a_n} and ΔC_V in figure 8. Such approximate limits are considered to describe the buffeting which, in general, would be encountered during similar maneuvers. However, the accuracy with which the buffet-intensity data presented herein, (which were obtained during maneuvering flight) represent the buffet intensities that would be encountered at some sustained lift coefficient, cannot be estimated.

The intensity of the buffeting as measured with the Statham accelerometer at the center of gravity ΔC_{a_n} and as measured with strain gages at the left wing root ΔC_V is summarized in figures 9 and 10, respectively. The buffet data presented in these figures were determined, for the most part, from approximate limits faired about measured buffet intensities as shown in figure 8. At the higher lifts, however, it was felt that upper limits could not be accurately drawn and so some representative individual values of ΔC_{a_n} and ΔC_V have been included in figures 9 and 10 and are plotted with flagged symbols. No data were obtained below a Mach number of 0.7 at moderate lift coefficients above the buffet boundary. The data shown in figures 9 and 10 at high lift below $M \approx 0.7$ were taken during essentially uncontrolled pitching oscillations following turns initiated at Mach numbers on the order of 0.8.

In general, the variation of the buffet intensity measured at the airplane center of gravity with Mach number and lift (fig. 9) is similar to that of other fighter-type airplanes except that the various levels of ΔC_{a_n} occur at lower values of lift and angle of attack. Mach number appears to have small effect on the variation of ΔC_{a_n} with lift and angle of attack up to a Mach number of about 0.9. It should be noted that the characteristic decrease and then increase with Mach number in the normal-force coefficients and angles of attack that define the buffet boundary and the lower buffet intensities is confined to the small Mach number range from 0.88 to 0.96.

The wing-panel buffet loads summarized in figure 10 have a generally similar variation with Mach number and lift as the acceleration data of figure 9. It should be realized that the values of ΔC_V are measurements of the incremental structural shear load, and as such, are specific to this airplane. Design wing limit load for the XF-92A is estimated to be on the order of 28,000 pounds. For a dynamic pressure of 300 lb/sq ft, the data of figure 10 show that below an airplane normal-force coefficient of 0.6, the fluctuating wing buffet loads approached 5 percent of the estimated design limit load and that the peak values of wing buffet load approached 10 percent of the estimated design limit load at higher lift coefficients.

The relation between incremental wing-panel load and incremental acceleration at the airplane center of gravity is of interest since wing buffeting would appear to be the major cause of fuselage vibration. Investigation of this relationship has, so far, been of very limited extent for this airplane. The incremental acceleration Δa_n at the airplane center of gravity is plotted in figure 11 against the acceleration that would result from the direct action of twice the measured wing buffet load on a rigid body of mass equal to that of the present airplane without wings. The data indicate that the center-of-gravity accelerations were from 1.7 to 3.5 times the accelerations that would result from direct action of the buffet load.

Comparisons

The buffet boundary of the XF-92A is compared in figure 12 with the wing buffet boundary of the X-5 airplane at 60° sweepback (ref. 8). It may be seen that the buffet boundaries of the two airplanes are very similar except that the XF-92A experiences wing buffeting at angles of attack on the order of 4° lower than the X-5 and normal-force coefficients on the order of 0.2 lower than the X-5. The effect of buffeting on the maneuvering capabilities of the two airplanes is indicated by comparison of the values of normal load factor at which buffeting occurs. It may be seen in figure 12 that the early occurrence of buffeting for the XF-92A to some extent offsets the benefits of the inherent low wing loading of the delta wing.

Little data exist for comparison with the wing buffet loads presented herein. Extensive measurements of wing buffet loads encountered during stalls of a propeller-driven fighter-type airplane have been presented in reference 6. It was found therein that during a stall of 5-second duration, the maximum expected value of wing buffet load would be 12 percent of wing structural shear load at limit load factor. The value of 10 percent of estimated design limit load found herein for the XF-92A maximum wing buffet load cannot be directly compared with the data of reference 6 since the XF-92A loads were measured under transient conditions and the data of reference 6 were measured under steady conditions. It was also shown in reference 6 that the maximum buffet load increased on the order of 10 percent from stalls of less than 1-second duration to those of from 4- to 5-second duration. Accordingly, under steady conditions at high lift, the maximum values of XF-92A wing buffet load could approach 18 to 20 percent of estimated design limit load.

CONCLUDING REMARKS

The 60° delta-wing XF-92A airplane has attained normal-force coefficients on the order of 0.7 in the Mach number range from 0.6 to 0.9. Mach numbers up to 1.01 have been attained during dives at lower lifts. In the present tests, measurements were made of buffet-induced fluctuations in normal acceleration at the airplane center of gravity and of fluctuations in structural shear load of the left wing. The altitude range of the investigation varied from 25,000 to 38,000 feet.

Buffeting was experienced at normal-force coefficients on the order of 0.2 at Mach numbers up to 0.88 but existed at normal-force coefficients less than 0.1 at Mach numbers between 0.9 and 0.96. Buffeting was not encountered at Mach numbers between 0.96 and 1.01 at low lifts.

At the altitudes of the present investigation, the buffeting encountered below the reduction in stability boundary was barely noticed by the pilot. Above the reduction in stability boundary the pilot described the buffeting as "moderate," but in comparison with the stability difficulties experienced by the airplane, the buffeting was not considered a problem. In general, the variation of buffet intensity with Mach number and lift is similar to that of other fighter-type airplanes except that the various levels of buffet intensity occur at lower values of lift and angle of attack. At a dynamic pressure of 300 pounds per square foot the peak values of wing buffet loads approached 10 percent of the estimated design limit load and below a normal-force coefficient of 0.6 the wing buffet loads approached 5 percent of the estimated design limit load.

High-Speed Flight Station,
National Advisory Committee for Aeronautics,
Edwards, Calif., November 15, 1954.

REFERENCES

1. Sisk, Thomas R., and Muhleman, Duane O.: Longitudinal Stability Characteristics in Maneuvering Flight of the Convair XF-92A Delta-Wing Airplane Including the Effects of Wing Fences. NACA RM H54J27,

2. Keener, Earl R.: Wing Pressure Distributions at Low Lift for the XF-92A Delta-Wing Airplane at Transonic Speeds. NACA RM H54H06, 1954.

3. Bellman, Donald R., and Sisk, Thomas R.: Preliminary Drag Measurements of the Consolidated Vultee XF-92A Delta-Wing Airplane in Flight Tests to a Mach Number of 1.01. NACA RM L53J23, 1954.

4. Dublin, M., Wolcott, V. V., and Wilde, J. W.: Model 7002 Ground Vibration Test. Rep. ZU-7002-001 (Contract W33-038ac14547), Consolidated Vultee Aircraft Corp., May 19, 1948.

5. Zalovcik, John A.: A Radar Method of Calibrating Airspeed Installations on Airplanes in Maneuvers at High Altitudes and at Transonic and Supersonic Speeds. NACA Rep. 985, 1950. (Supersedes NACA TN 1979.)

6. Huston, Wilber B., and Skopinski, T. H.: Measurement and Analysis of Wing and Tail Buffeting Loads on a Fighter-Type Airplane. NACA TN 3080, 1954.

7. Anderson, Adrien E.: Chordwise and Spanwise Loadings Measured at Low Speed on Large Triangular Wings. NACA RM A9B17, 1949.

8. Briggs, Donald E.: Flight Determination of the Buffeting Characteristics of the Bell X-5 Research Airplane at 58.7° Sweepback. NACA RM L54C17, 1954.

TABLE I.- PHYSICAL CHARACTERISTICS OF THE XF-92A AIRPLANE

Wing:	
Area, sq ft	425
Span, ft	31.33
Airfoil section	NACA $65_{(06)}$-006.5
Wing-panel area, outboard of root strain-gage station, sq ft	137.1
Mean aerodynamic chord, ft	18.09
Aspect ratio	2.31
Root chord, ft	27.13
Tip chord	0
Taper ratio	0
Sweepback (leading edge), deg	60
Incidence, deg	0
Dihedral (chord plane), deg	0
Elevons:	
Area (total, both, aft of hinge line) sq ft	76.19
Span (one elevon), ft	13.35
Chord (aft of hinge line, constant except at tip), ft	3.05
Movement, deg	
Elevator:	
Up	15
Down	5
Aileron, total	10
Operation	Hydraulic
Vertical tail:	
Area, sq ft	75.35
Height, above fuselage center line, ft	11.50
Rudder:	
Area, sq ft	15.53
Span, ft	9.22
Travel, deg	±8.5
Operation	Hydraulic
Fuselage:	
Length, ft	42.80
Power plant:	
Engine	Allison J33-A-29 with afterburner
Rating:	
Static thrust at sea level, lb	5,600
Static thrust at sea level with afterburner, lb	7,500
Weight:	
Gross weight (560 gal fuel), lb	15,560
Empty weight, lb	11,808
Center-of-gravity locations:	
Gross weight (560 gal fuel), percent M.A.C.	25.5
Empty weight, percent M.A.C.	29.2
Moment of inertia in pitch, slug-ft^2	35,000
Wing-panel weight, lb:	
Right	973
Left	1,089

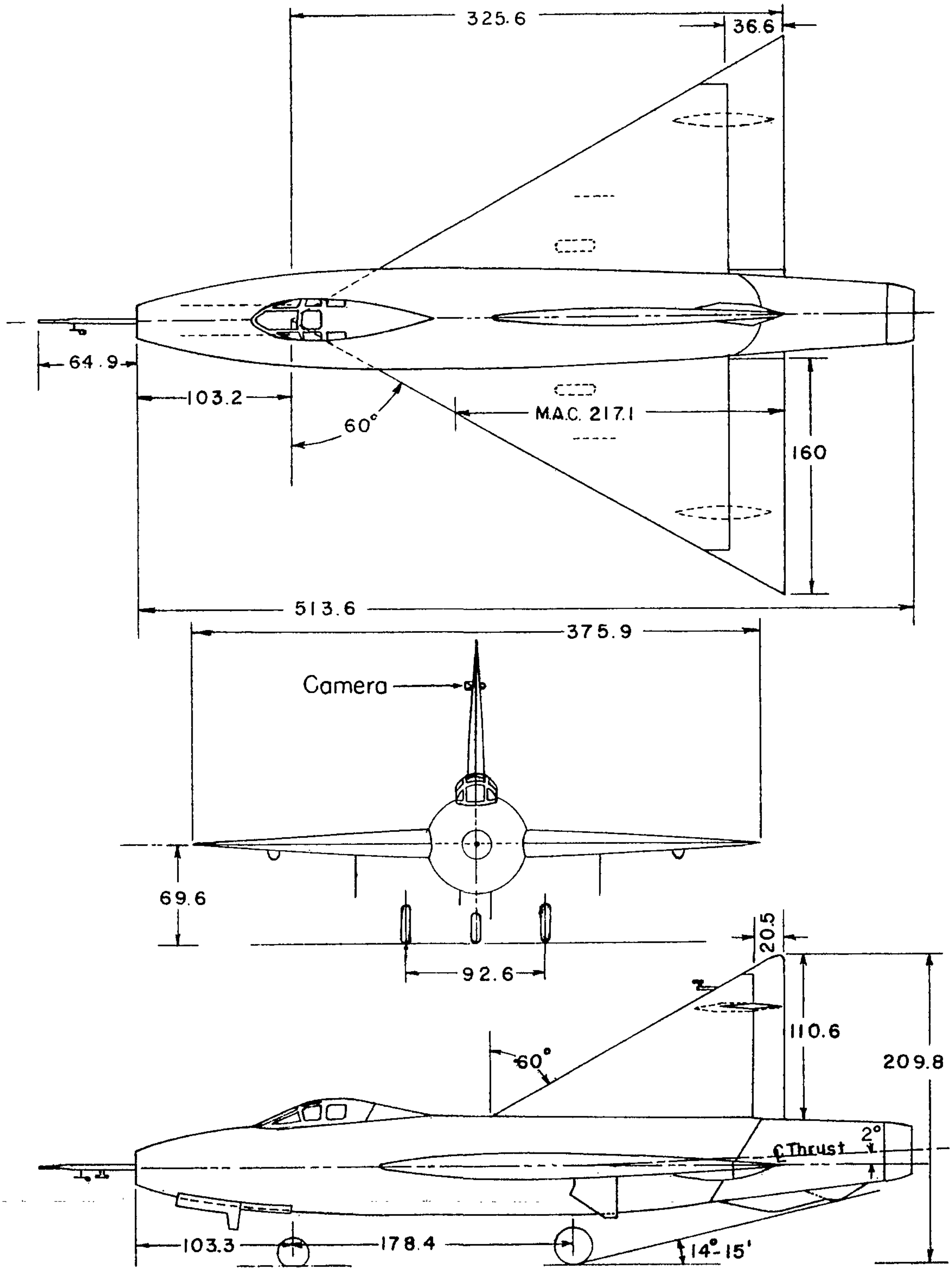
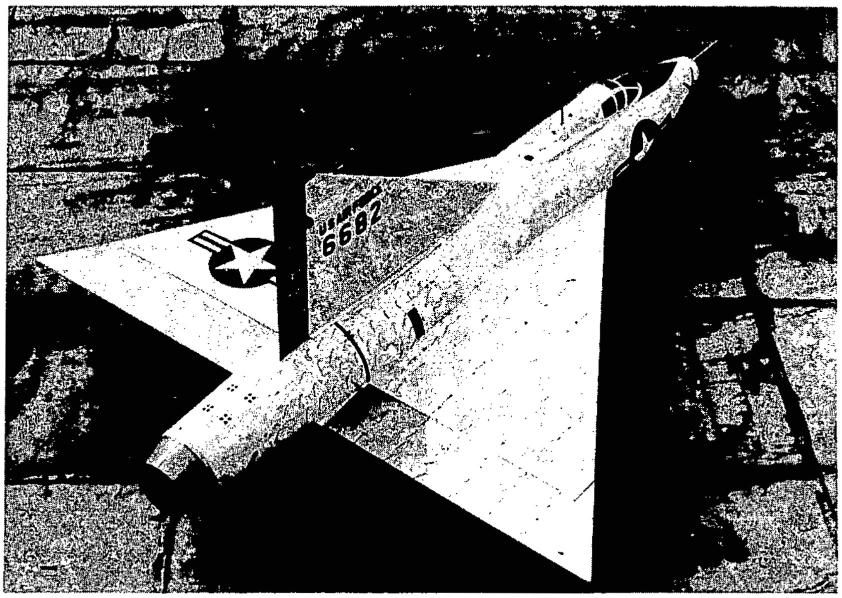
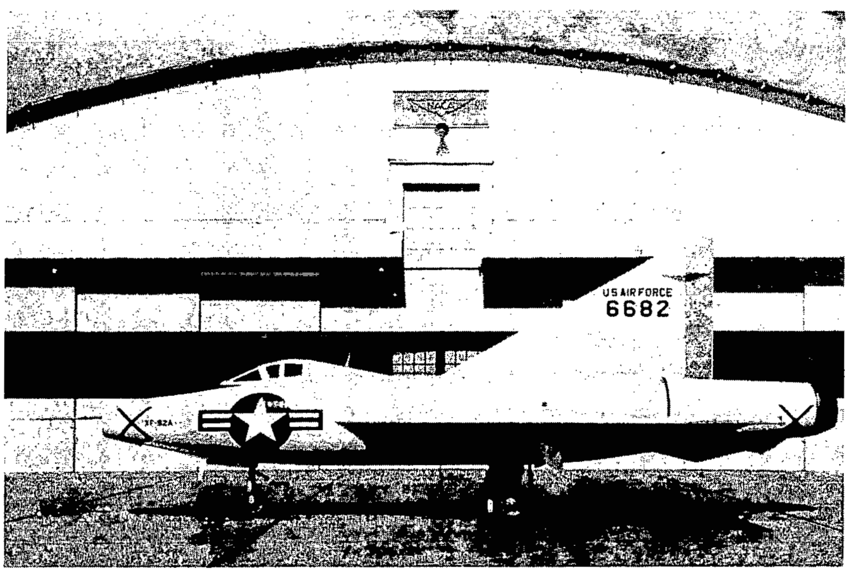


Figure 1.- Three-view drawing of the XF-92A airplane. All dimensions in inches.



(a) Three-quarter rear overhead view.



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(b) Side view.

Figure 2.- Photographs of XF-92A airplane.

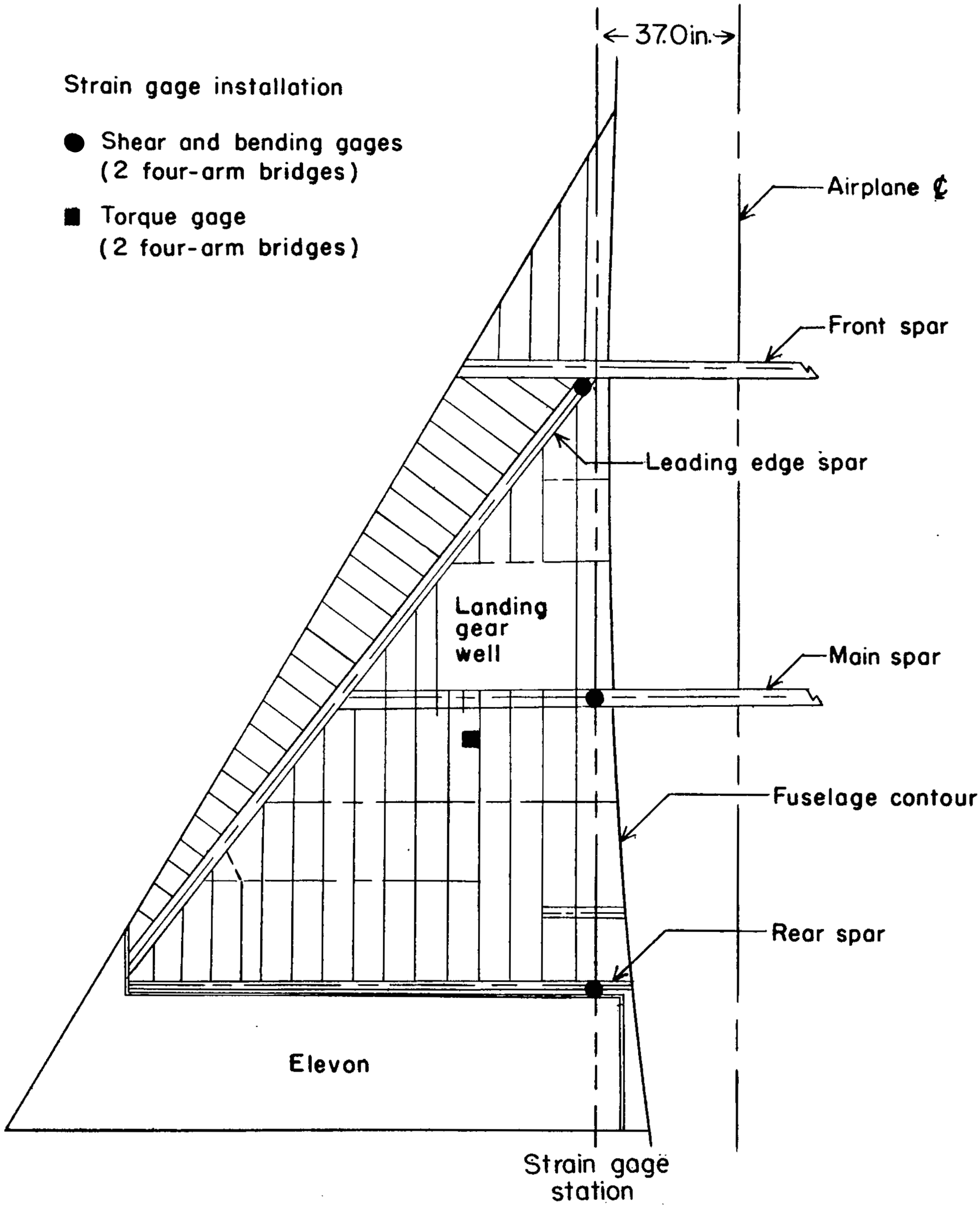


Figure 3.- Main structural elements and strain-gage bridge locations. XF-92A airplane left wing.

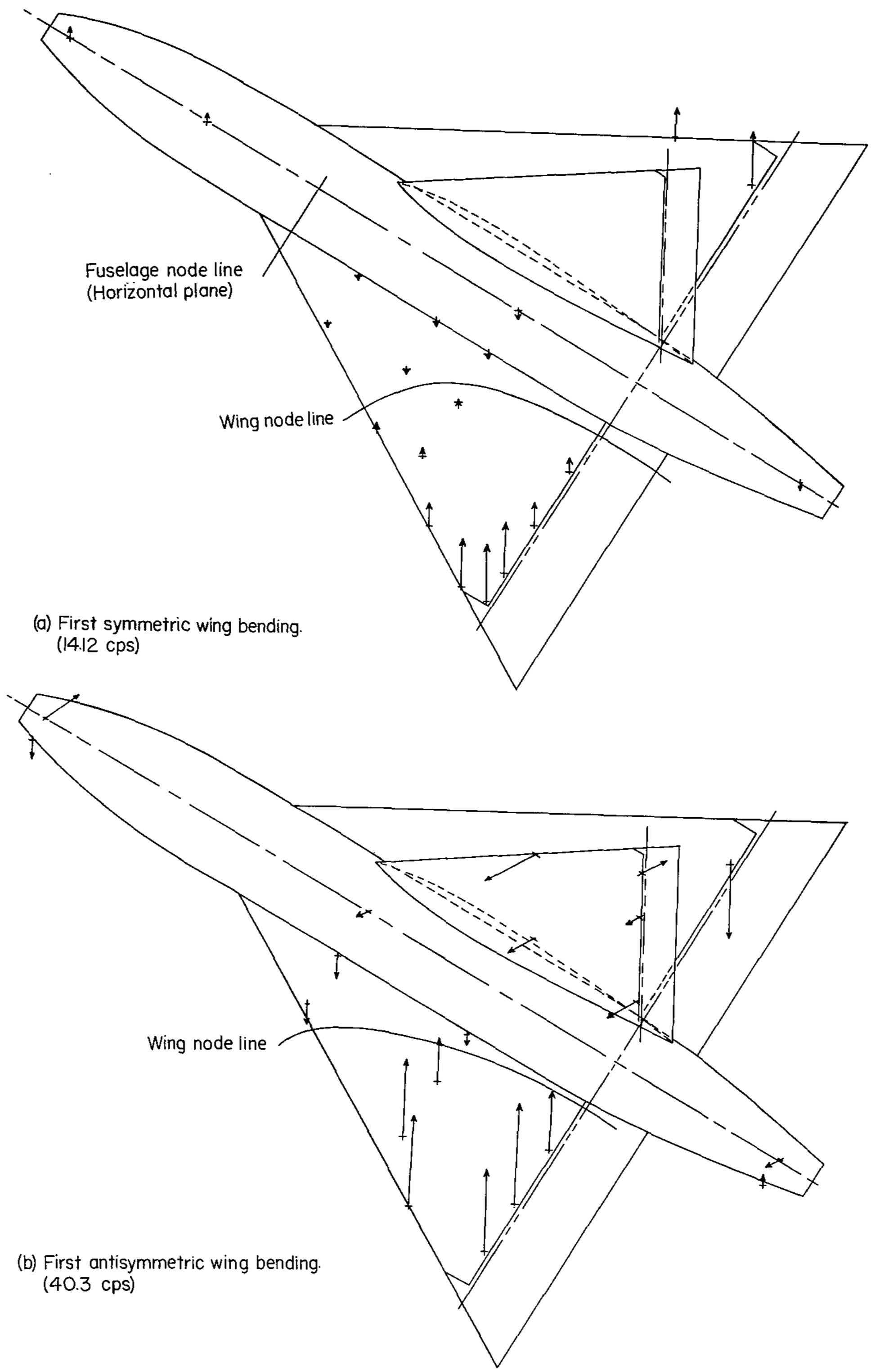
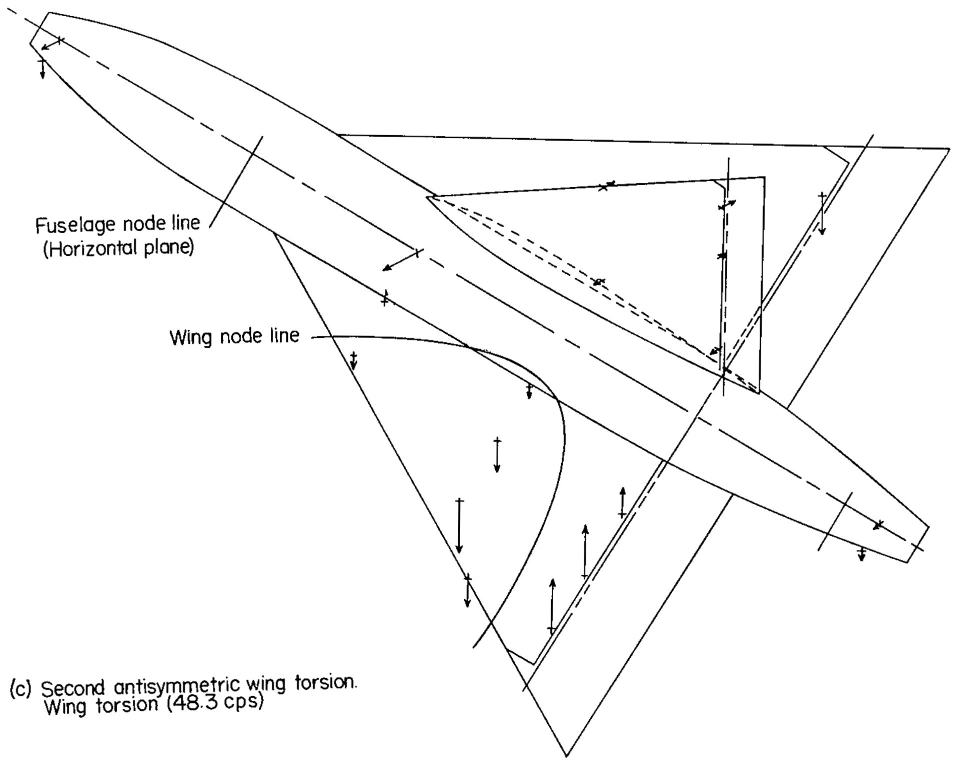
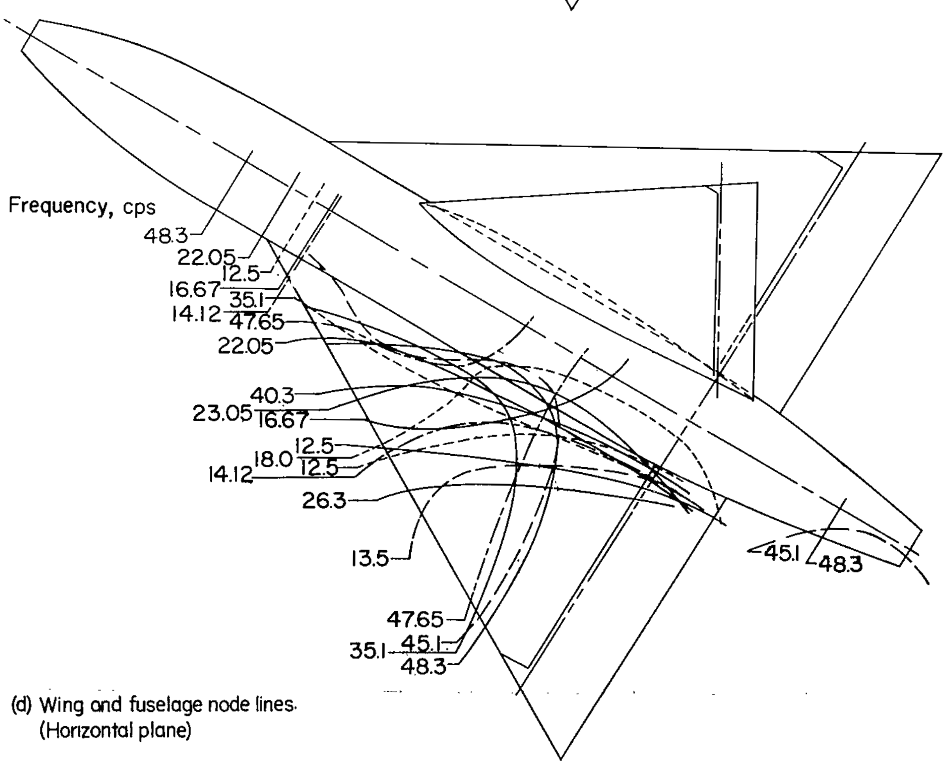


Figure 4.- Representative mode shapes and node lines during manufacturer's ground vibration tests. XF-92A airplane.



(c) Second antisymmetric wing torsion.
Wing torsion (48.3 cps)



(d) Wing and fuselage node lines.
(Horizontal plane)

Figure 4.- Concluded.

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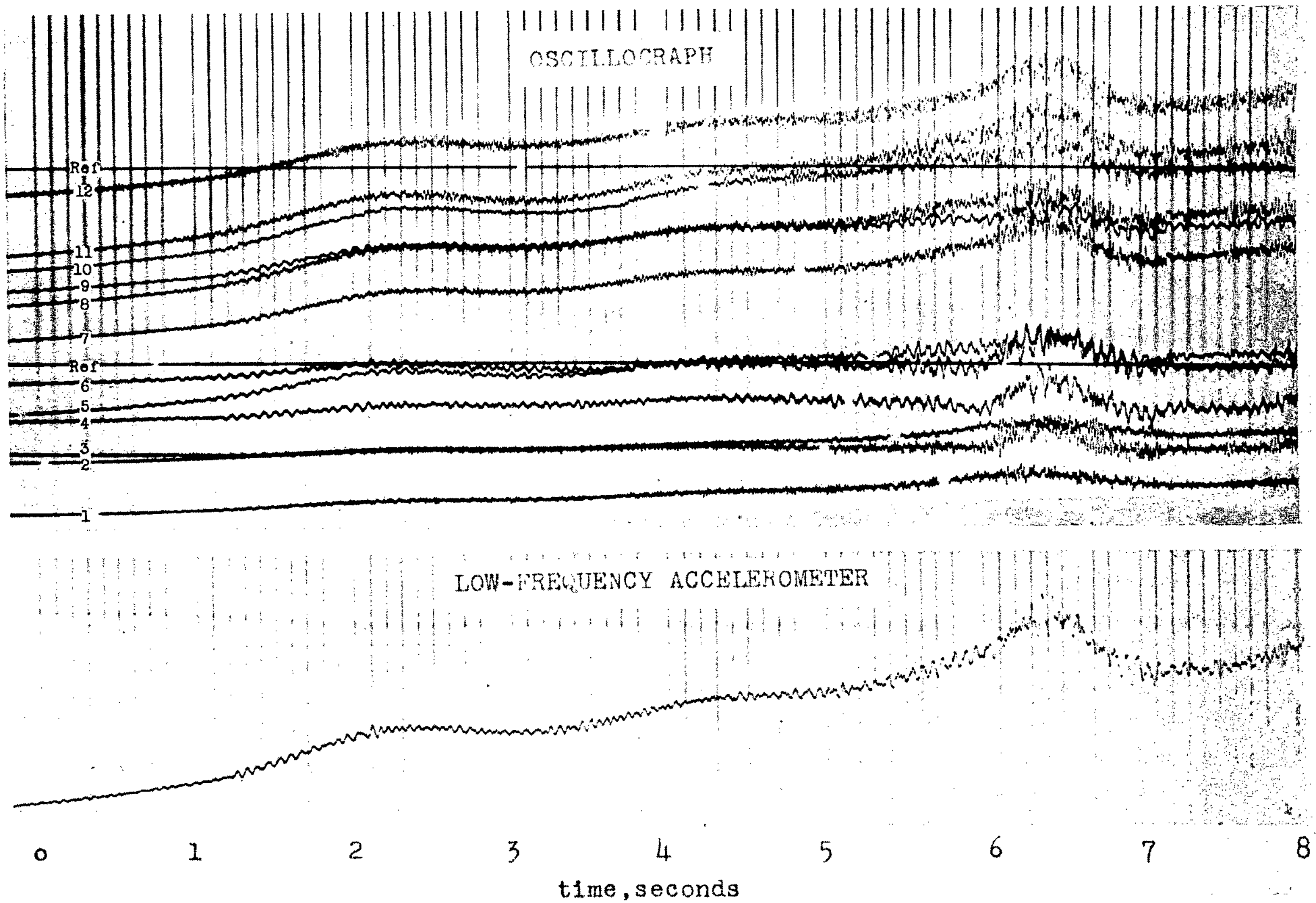

Figure 5.- Typical records taken during buffeting flight. XF-92A airplane. $M \approx 0.7$; $h_p \approx 30,000$ feet.

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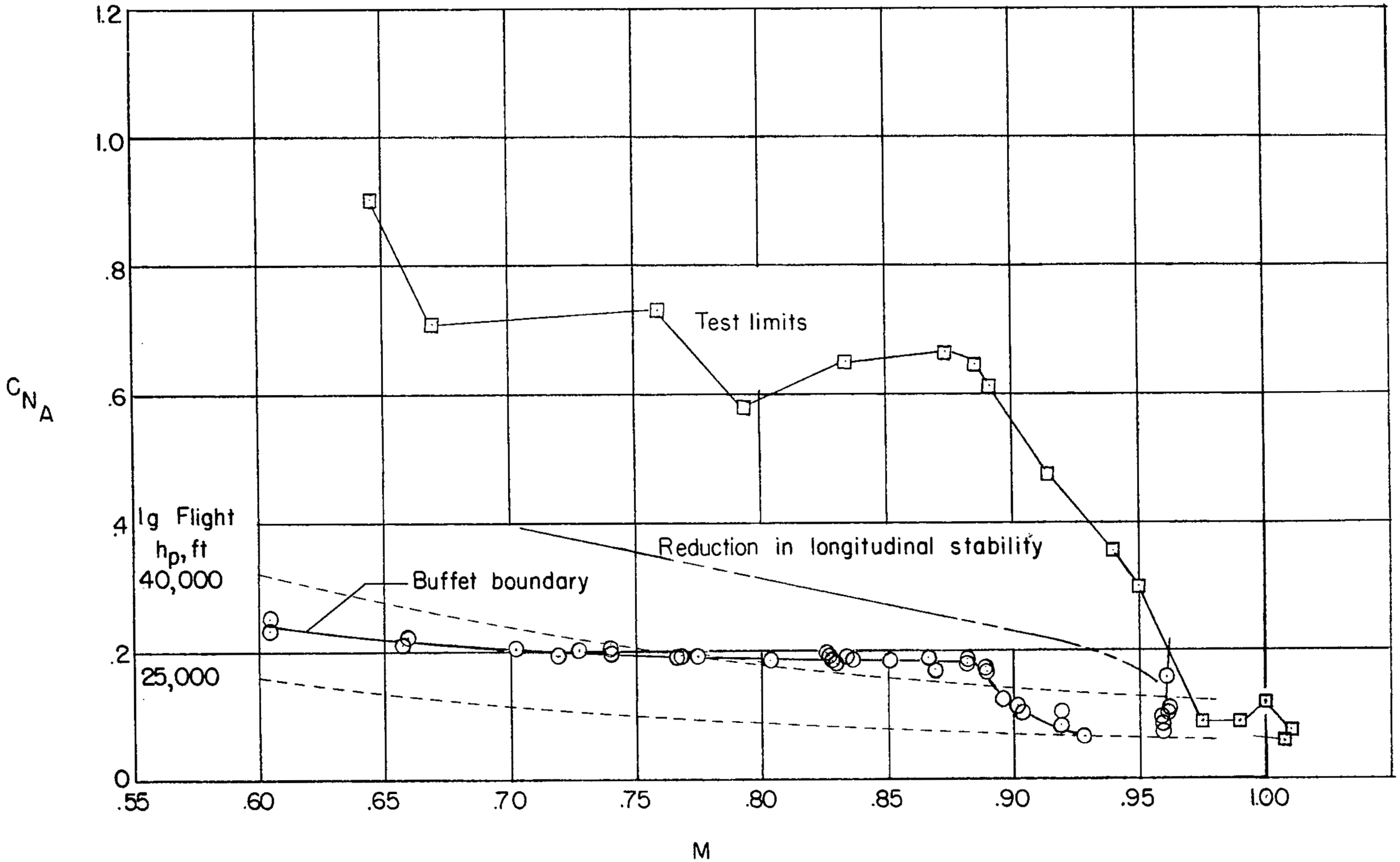

(a) Variation with Mach number and normal-force coefficient.

Figure 6.- Buffet boundary, boundary for reduction in longitudinal stability, and test limits of the present investigation. XF-92A airplane.

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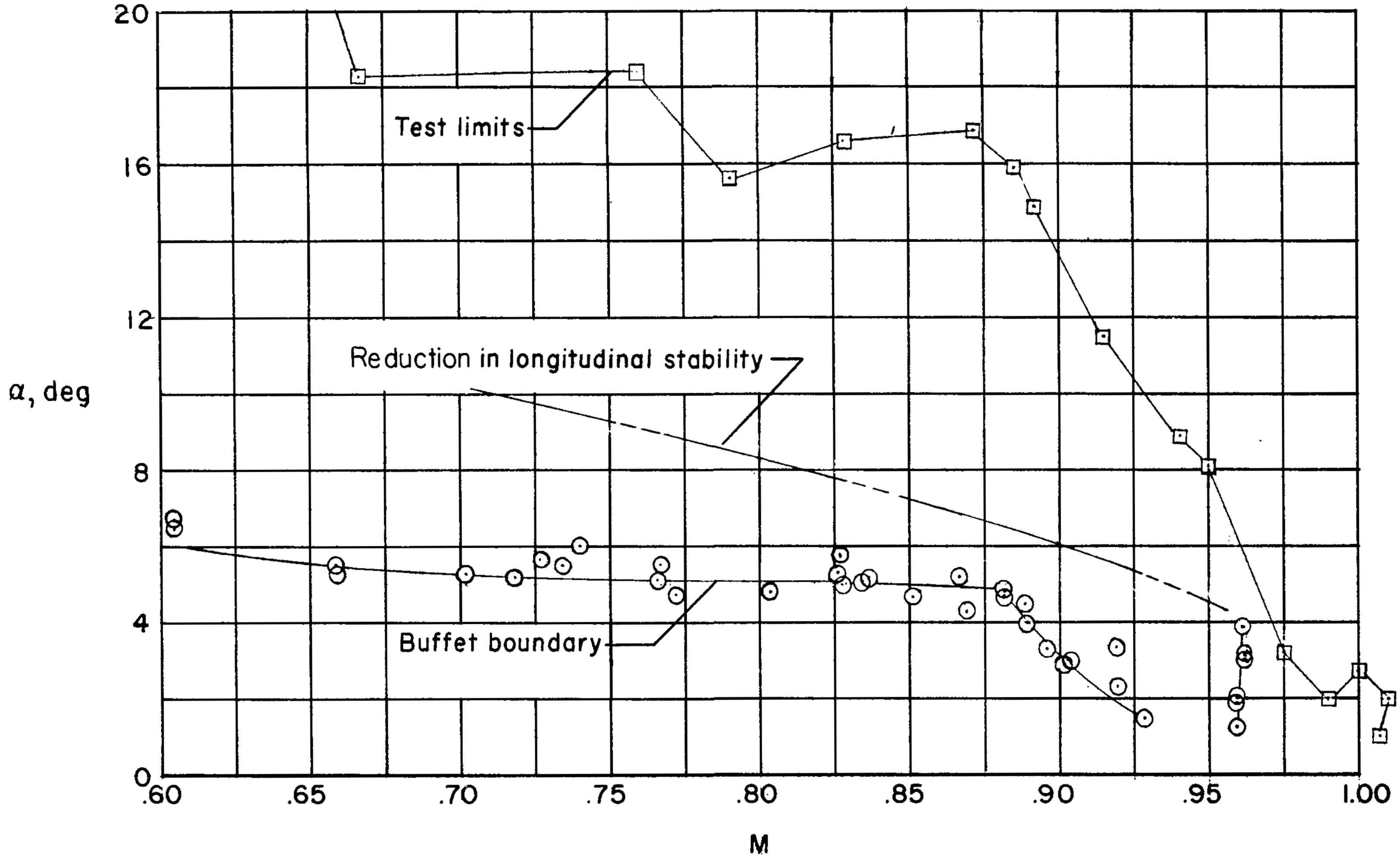

(b) Variation with Mach number and angle of attack.

Figure 6.- Concluded.

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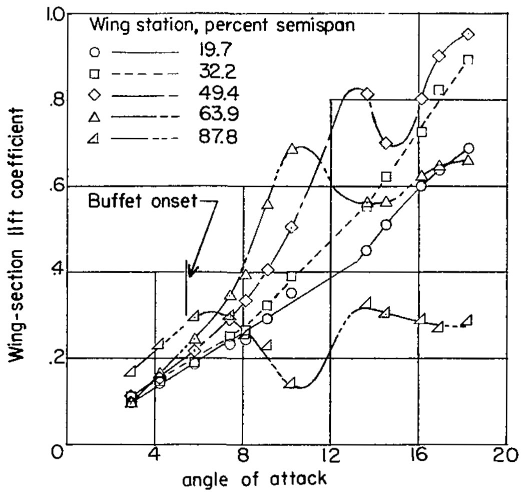
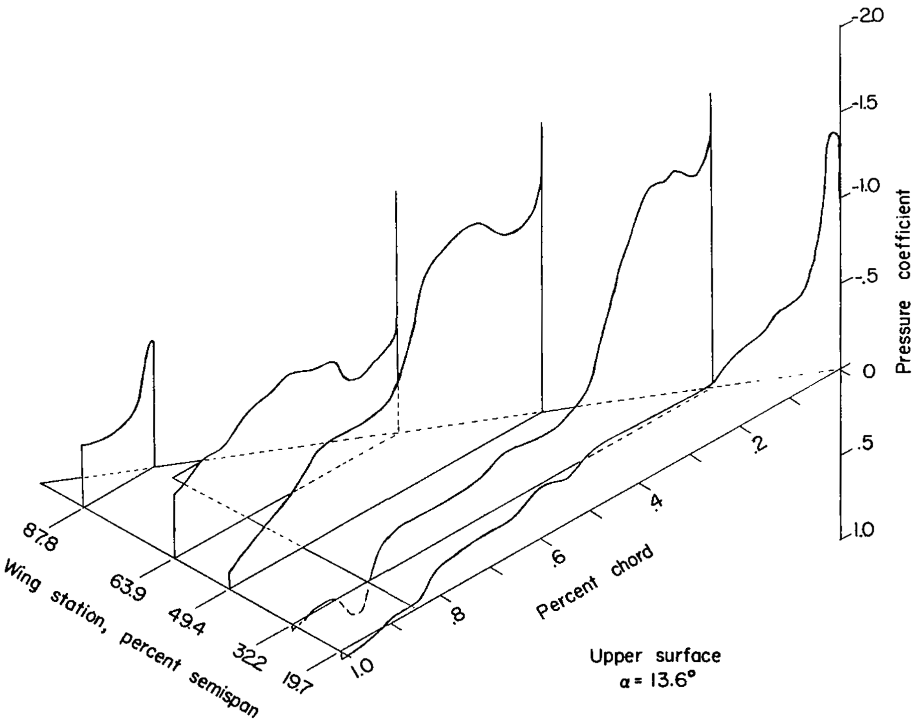
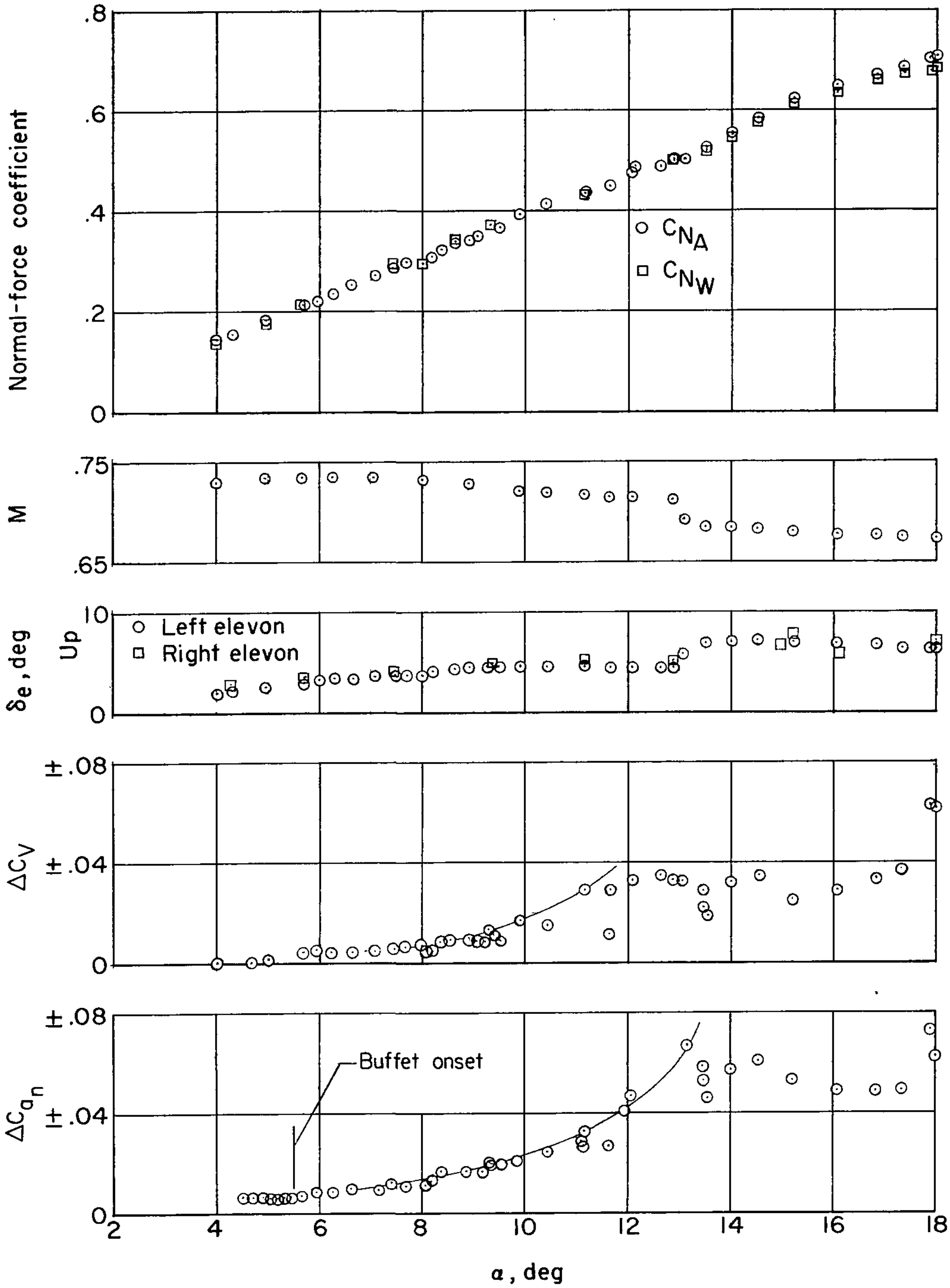


(a) Variation of section lift coefficients with angle of attack.



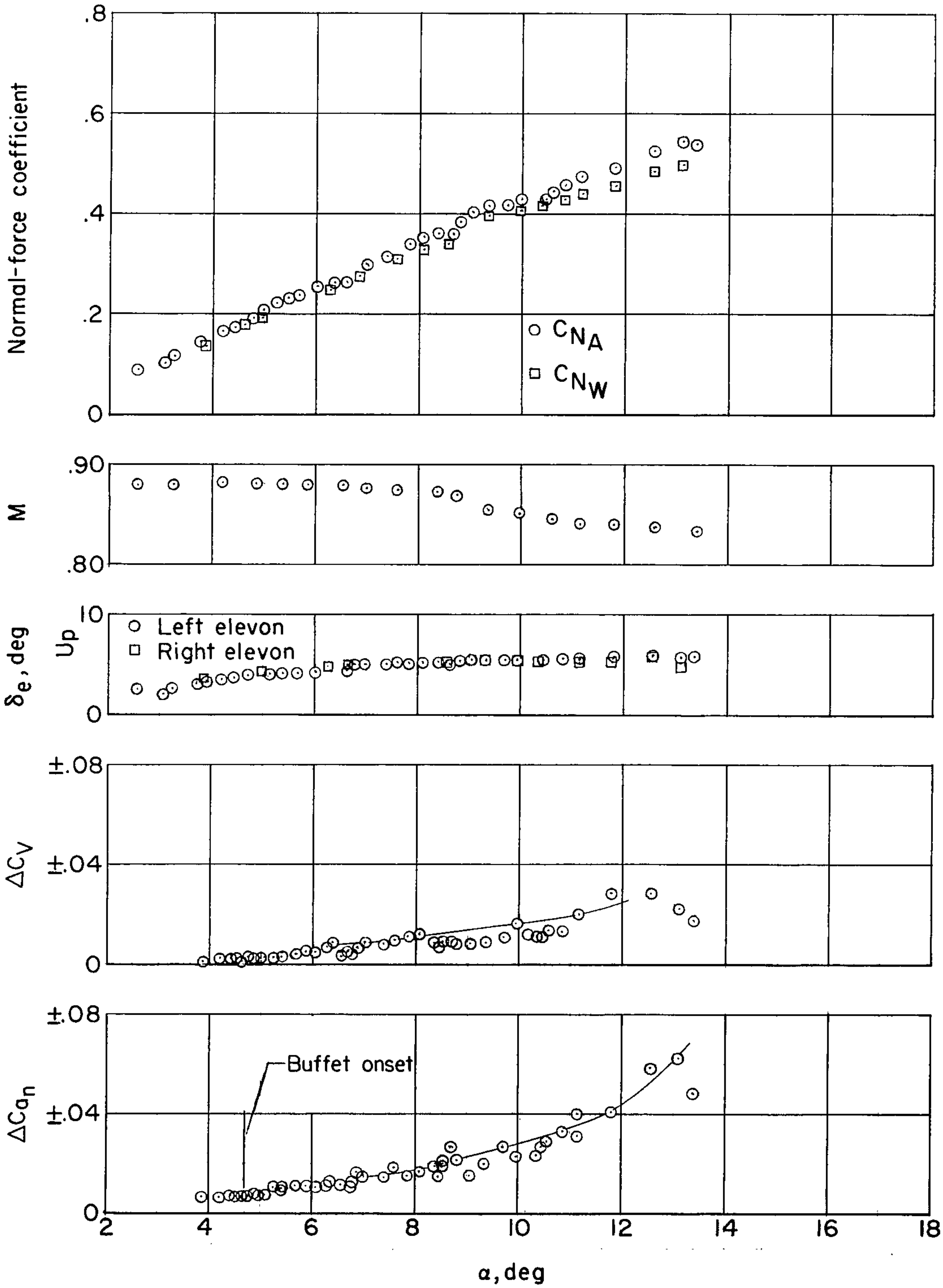
(b) Isometric view of typical upper surface pressure distribution.

Figure 7.- Results of pressure measurements on left wing at a Mach number of 0.7. XF-92A airplane.



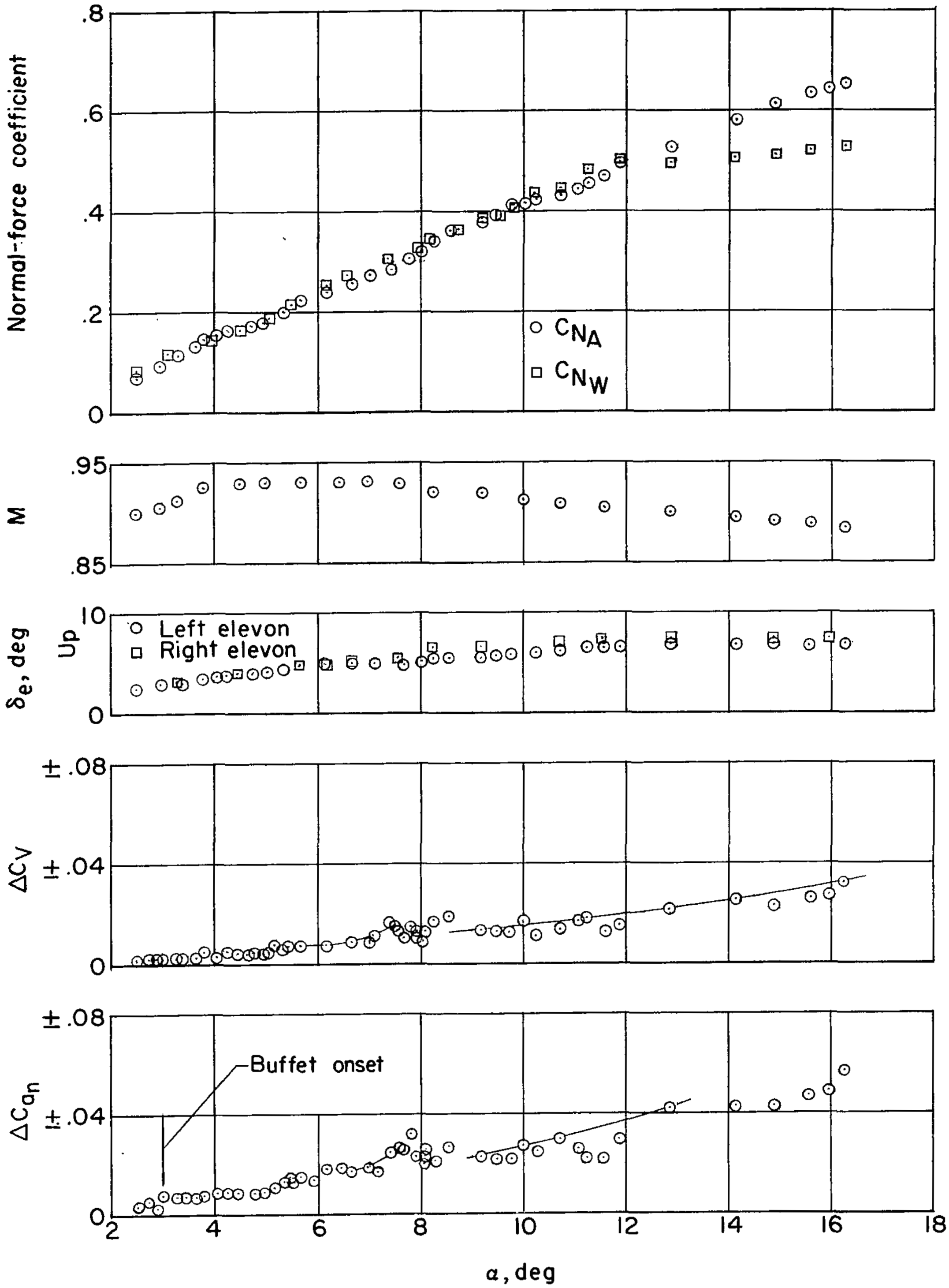
(a) $M \approx 0.7$; $h_p \approx 30{,}000$ feet.

Figure 8.- Typical values of buffet intensity, ΔC_{a_n} and ΔC_V, together with pertinent steady quantities taken during three wind-up turns. XF-92A airplane.



(b) $M \approx 0.85$; $h_p \approx 32{,}000$ feet.

Figure 8.- Continued.



(c) $M \approx 0.9$; $h_p \approx 38{,}000$ feet.

Figure 8.- Concluded.

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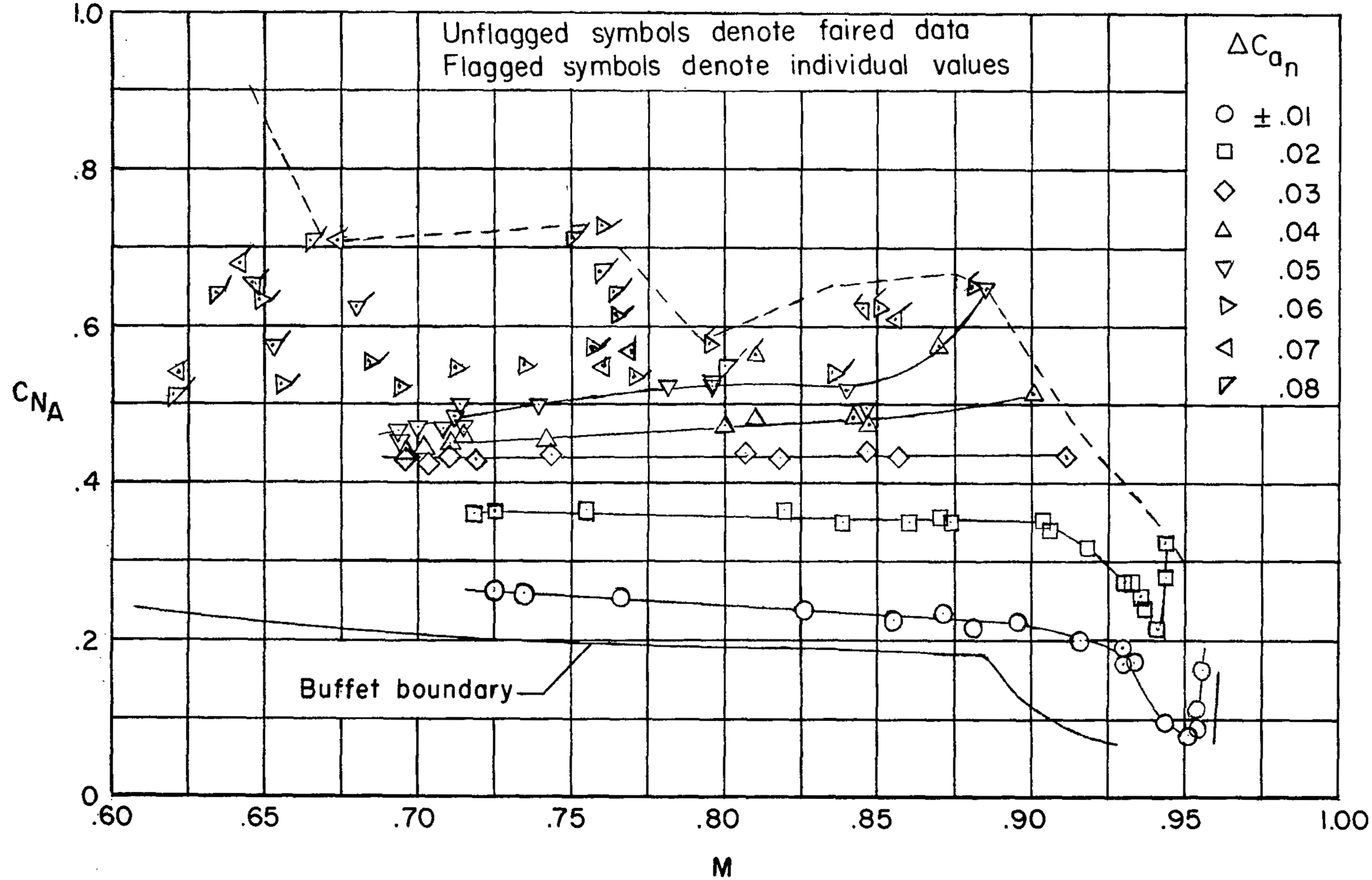

(a) Variation with normal-force coefficient and Mach number.

Figure 9.- Intensity of buffeting at airplane center of gravity. XF-92A airplane.

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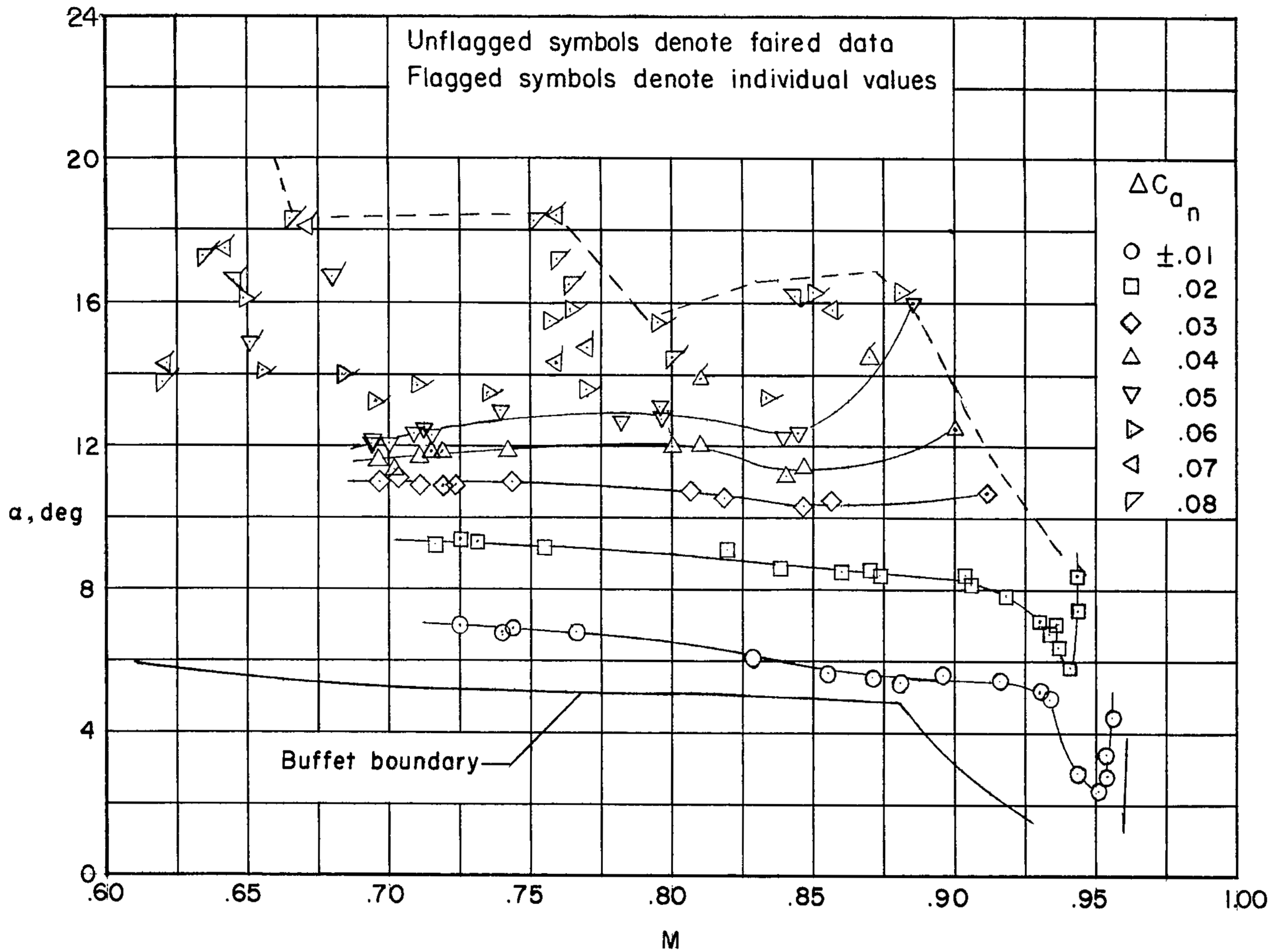

(b) Variation with angle of attack and Mach number.

Figure 9.- Concluded.

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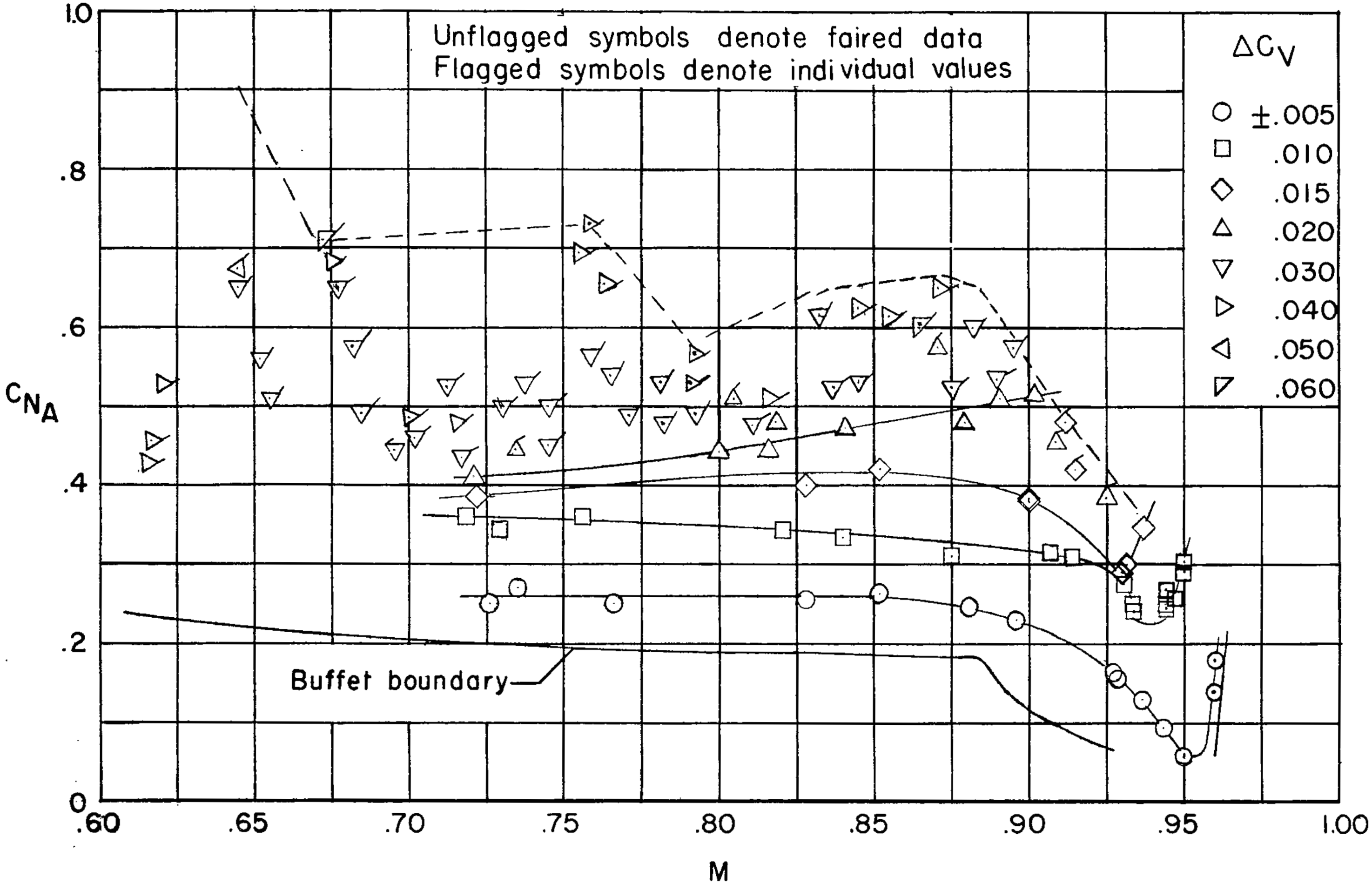

(a) Variation with normal-force coefficient and Mach number.

Figure 10.- Coefficient of incremental structural shear load due to buffeting of the left wing. XF-92A airplane.

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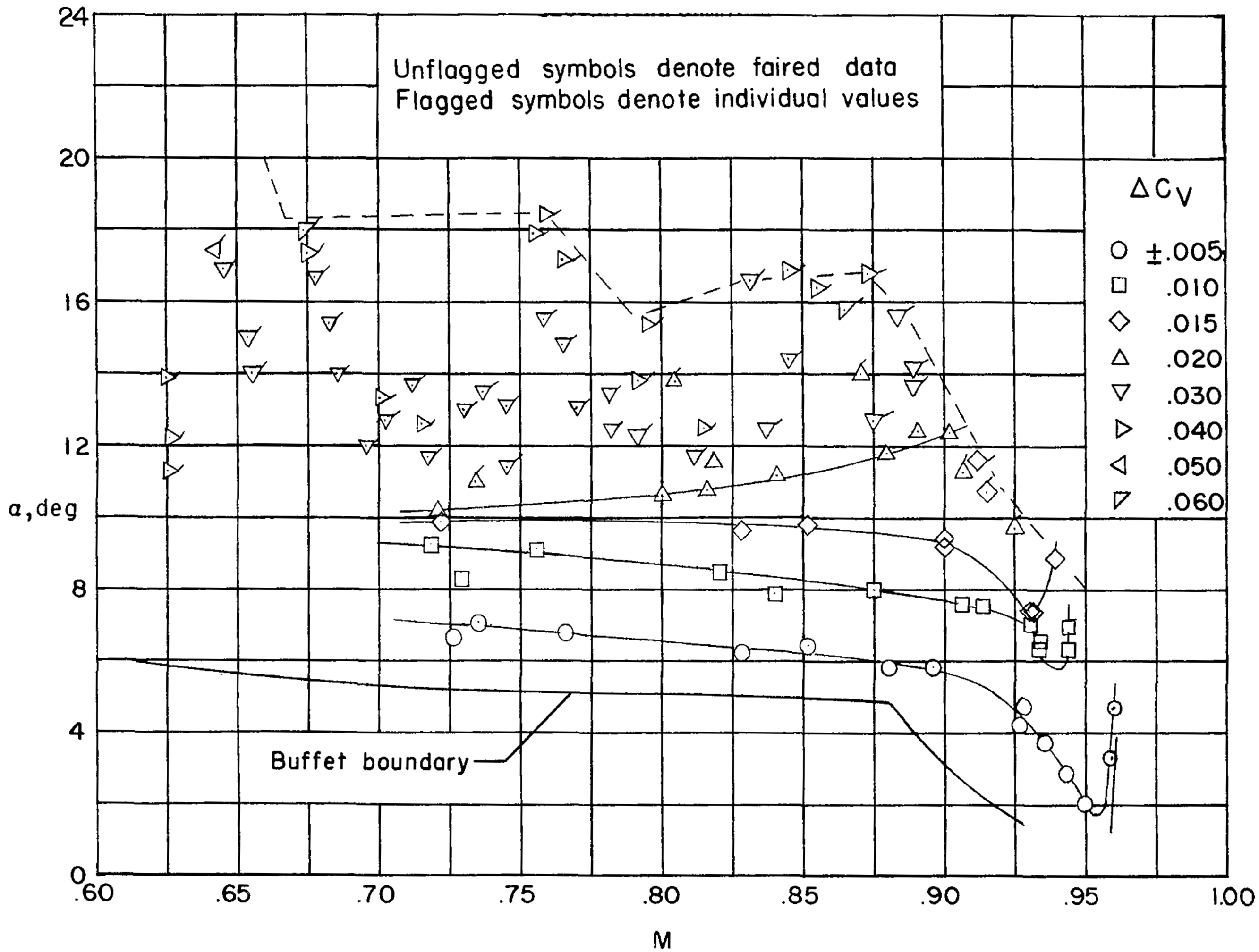

(b) Variation with angle of attack and Mach number.

Figure 10.- Concluded.

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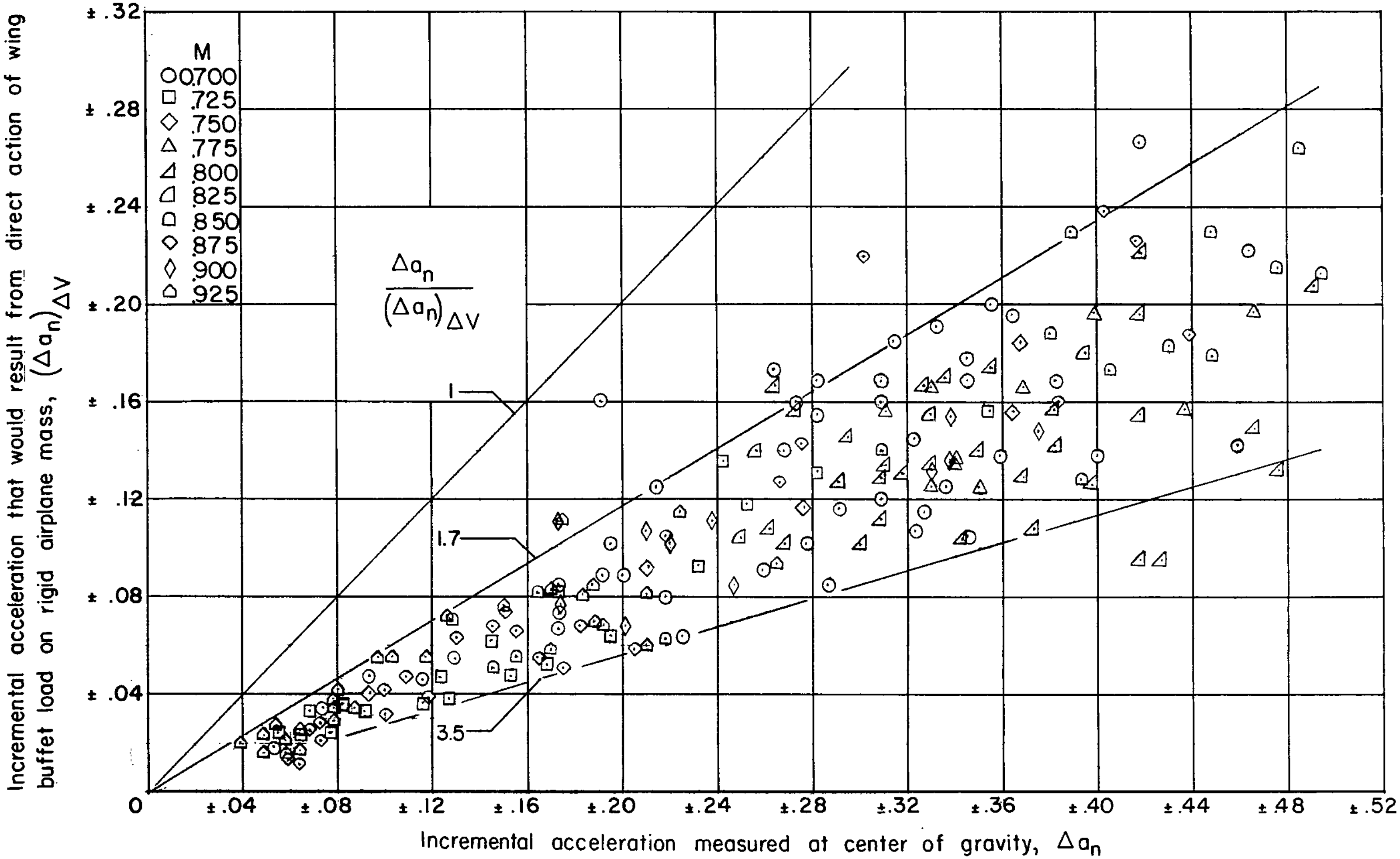

Figure 11.- Relation between incremental normal acceleration at airplane center of gravity and acceleration that would result from the direct action of wing buffet load on rigid airplane mass.

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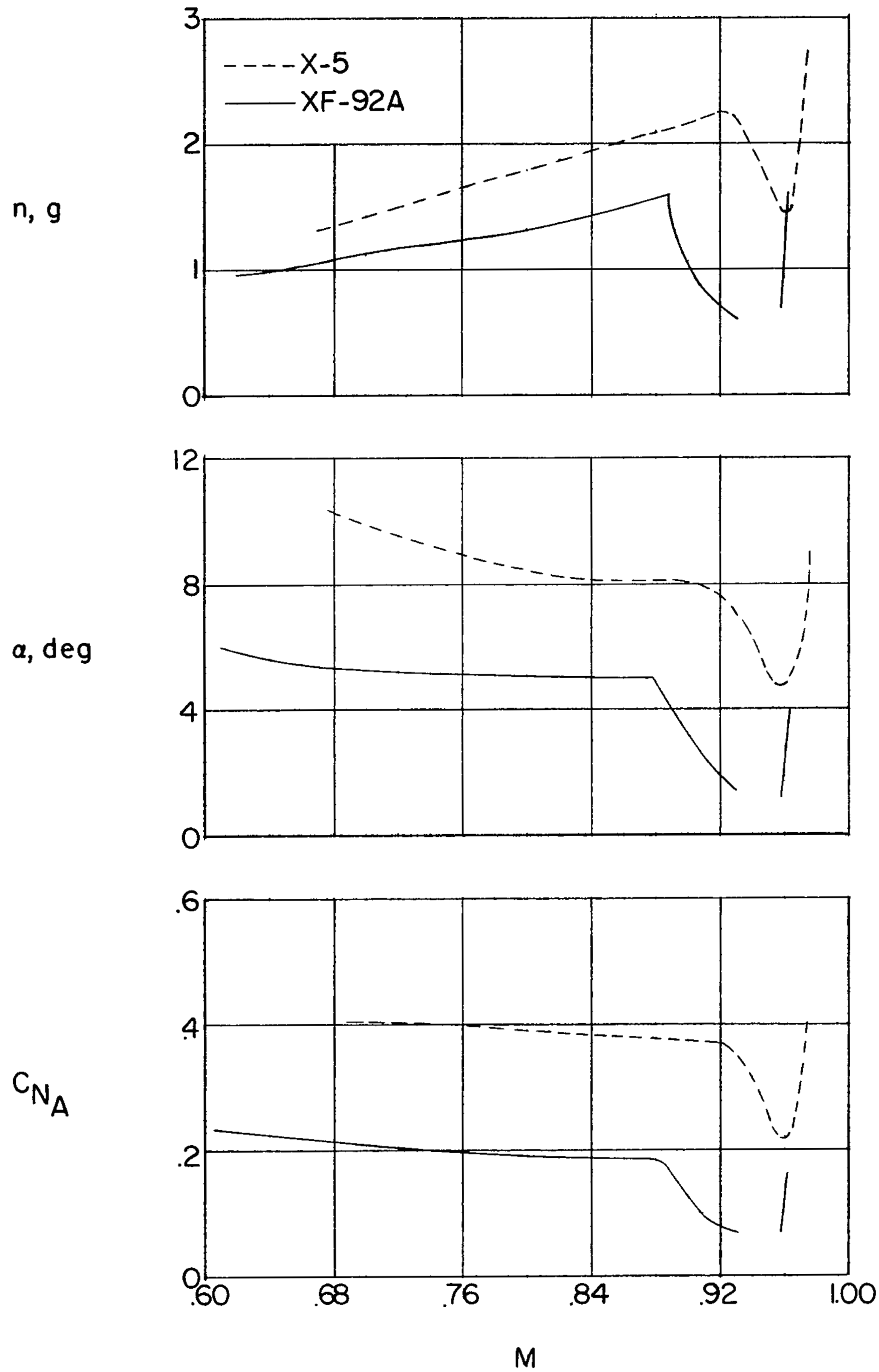

Figure 12.- Comparison of the boundaries for the onset of wing buffet of the XF-92A and the 60° swept-wing X-5 airplanes. h_p = 35,000 feet; W/S for X-5 = 48.5; W/S for XF-92A = 32.0.